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THE GENERAL TOXIC EFFECT OF SHALE RESINS ON WORKERS

by

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The chief product of the thermal treatment of combustible shales is resin. Shale resin is utilized as liquid fuel but is mainly used as chemical raw material for the production of a number of valuable products widely used in the national economy.

The toxicity of shale resins and their individual fractions has been experimentally investigated in much detail [6, 7, 12, 13, 14, 15, 16]. Data on the carcinogenic properties of shale resins are generalized in the works of P. A. Bogovskiy [1, 2] and Kh. T. Vakhter [3]. Information on the effect of shale resins on the human body is extremely sparse. This is to a certain degree due to the fact that working in contact with shale resins does not cause pronounced cases of poisoning with specific clinical symptomatology or markedly limit the ability to work. There only exists data on the local effect of shale resins on the skin and mucous membranes of the respiratory passages [4, 8, 9, 10, 11]. For example, according to the data of I. P. Maripuu and N. A. Shamardin [9], in 40% of workers suffering from chronic bronchitis skin and inhalation tests with products of the thermal treatment of combustible shale, including resins, produce positive reactions. The studies of N. A. Loogna [8] proved that shale resins falling directly on the skin cause sensitization of the worker and allergic dermatitis. Data on the general toxic effect of shale resins is absent in the literature available to us.

Sanitary-hygienic studies of shale-processing departments of the shale-processing combine imeni V. I. Lenin and the shale-chemical combine "Kivilyi," conducted by the Laboratory of Toxicology and Labor Hygiene of the Institute show that the content of individual components of shale resin (hydrocarbons, phenols, etc.) in the air environment of work sites in the majority of cases does not exceed maximum permissible concentrations. However, it is necessary to take into account that workers are in fact exposed to the summary effects of these components. According to the data of Kh. Ya. Yanes [12], shale resin can enter the body not only through respiratory passages and the digestive tract, but also through intact skin. Besides shale resin, workers in the above-indicated departments are also exposed to the effect of carbon monoxide, sulfurous anhydride, the dust of combustible Kukersit shales or shale ash.

As our purpose was to study the effect of shale resins on worker health, an appropriate group was selected and the tests conducted on persons for whom the main occupational agent was shale resin.

All workers were examined by an occupational pathologist-therapist and a neuropathologist. Study data were entered on specially devised punch cards. In order to investigate the condition of the autonomic nervous system we determined the sensitivity of the skin to ultraviolet rays (we used a PRK-2 quartz lamp placed 50 cm away from the forearm to which was attached a Gorbachev-Dal'fel'd biodosimeter), sweat production and skin temperature of the digits, hands and feet. Besides clinical analysis of the blood, we also determined the content of free and bound phenols, sulfates, glucuronic acids and coproporphyrin in urine. To study nonspecific immunological reactivity of workers, our associate, A. Ostrat, determined general immunological reactivity according to the method of V. I. Ioffe and skin microflora according to the method described by N. N. Klemparskaya and O. G. Alekseyeva.

We examined a total of 115 persons (45 men and 70 women) working at the GGS and in the batch furnace department of the Shale Processing Combine imeni V. I. Lenin (at Kokhtla-Yarve) and the Shale-Chemical Combine "Kivilyi." The majority (91) were between the ages of 30 and 49. The average length of time working in contact with shale resins for the SPC imeni Lenin employees was 12.2 years and for those from the "Kivilyi" combine — 11.4 years. Approximately 80% of the total number of persons examined worked as operators, the rest were metal craftsmen and laboratory workers.

The overwhelming majority of the total number of examinees experienced subjective disorders (92). The most frequent complaints were headaches (33%), fatigue (22%) and abdominal pains (25%).

From the data obtained in therapeutic examination we must note the following: chronic bronchitis was diagnosed in five persons and hypertension in 11. Of individual symptoms the most frequent was palpatory tenderness of the epigastric area (in 28 persons).

In studying the condition of the autonomic nervous system asymmetry was found in the intensity of the reaction of the skin to ultraviolet rays in 41% of the examinees: thermoasymmetry of the fingers in 31% and asymmetry of sweating of the fingers in 15%. On the basis of complaints and objective study of the nervous system we detected functional damage in 32% of the workers. Primarily detected was deviation of the vegetative dystonia type (17%) or asthenovegetative syndrome (11.5%). Asthenic syndrome was rare (3.5%).

Blood analysis data showed that in the overwhelming majority of cases they were within normal limits. A tendency was observed toward increased hemoglobin content and number of leukocytes. Eosinophilia was found in approximately 15% of cases.

*Expansion unknown.

In a number of cases deviations from normal were found during special biochemical tests. For example, the excretion of free phenols with urine exceeded 200 mg/l in 13% and the excretion of total phenols exceeded 250 mg/l in 11% of the examinees. 27% showed a coefficient indicating a ratio of organic sulfates excreted with urine to total sulfates above normal (normal coefficient about 30%). Excretion of coproporphyrin with urine was elevated in 24% (normal about 4.58%).

Studies of nonspecific immunological reactivity showed that immunological resistance was lowered in 60% of the workers, while in the control group the number of persons with reduced resistance did not exceed 20%.

With regard to interpretation of these data, the authors of the work feel it necessary to express the following observations. Subjective symptoms of functional disturbances of the central and autonomic nervous system must be explained, primarily, by the effect of hydrocarbons and phenols which, as is known, have a pronounced toxic effect on the central nervous system and are some of the basic components of shale resins. For example, generator resin contains 53.7% hydrocarbons and 24.6% phenols [5].

The appearance of eosinophilia in a number of workers agrees with the data of N. A. Loogna [8] on the sensitizing effect of shale resins. Shifts in biochemical indices indicate the entrance of phenols into the body (increased excretion of phenols with urine), the intensity of detoxification processes (increased excretion of sulfates and glucuronic acid with urine), and disturbance of metabolic processes (increased excretion of coproporphyrin with urine).

Comparison (using arithmetical mean with standard deviation) of two groups of people, some of whom had functional disturbances of the nervous system and other symptoms of an occupational character, with another group consisting of persons without subjective disorders showed that the excretion of free and total phenols, as well as sulfates, in the first group is significantly higher than in the second.

In particular, the excretion of free phenols in the first goup was 211±22 mg/l, in the second — 176±17 mg/l; the excretion of total phenols was 253±43 mg/l and 207±10 mg/l, the coefficient of the excretion of sulfates was 29±8% and 23.3±6% respectively. At the same time a tendency toward increased excretion of coproporphyrin and glycuronic acid was observed in the first group in comparison with corresponding data from the second group.

The data obtained verify that disorders detected in persons of the first group are due to the effect of toxic substances.

Reduction of nonspecific immunological resistance among the examinees reflects the negative effect of shale resins on the complex protective mechanisms of the body.

It is necessary to point out that development of the above-named disturbances depended not so much on the length of employment as on individual sensitivity of the workers to a given toxic substance. However, these disturbances do not deprive the examined workers of their ability to work but require regular medical observations.

This study shows that obtaining detailed and prompt (in the pre-intoxication period) information about initial disturbances requires comprehensive tests as the detected signs are individually nonspecific. This is primarily due to the effect of small concentrations of shale resins on workers. To a certain degree this is probably also connected with the complex chemical composition of shale resins as a result of which the effect of this substance is not concentrated in one link in the vital activity of the body, but seems to be scattered over many points of application. However, the combination of individual nonspecific signs forms a complex which is very typical and persistent for persons working in contact with shale resins.

CONCLUSIONS

1. The presence of subjective disorders, functional disturbances of the central and autonomic nervous system; increased excretion of phenols, sulfates and coproporphyrin with urine and decreased nonspecific immunological resistance in some examinees indicate the general toxic effect of shale resin on the health of workers. The detected initial changes do not deprive examined workers or their ability to work.

2. To obtain necessary information on the state of health of workers in shale-processing plants, main consideration must be given in periodic prophylactic medical examinations to determination of the functional state of the central and autonomic nervous system and to our recommended biochemical analyses (determination of the content of phenols, sulfates and coproporphyrin in urine).

3. Results of the examination show that in shale-processing departments of shale-chemical combines it is necessary to devise and implement further measures for bettering working conditions. Along with improving the technical aspect of the industry, it is necessary to give a great deal of attention to measures promoting increased resistance of workers to toxic substances (vitaminization, rational diet, avoidance of the abuse of alcohol, etc.), as well as to sanitary-hygienic education of workers (teaching personal hygiene habits, observance of safety rules, etc.).

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